THE EFFECT OF TOE TRIMMING ON HEAVY TURKEY TOMS' PRODUCTIVITY AND WELFARE

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ABSTRACT

Toe trimming within the turkey industry has been used for over four decades as a method for controlling carcass scratching, and by doing so, achieving better grades and lower condemnation rates. The industry has changed greatly since the 1970's, when the majority of the research on the procedure was completed. The technology used for toe trimming has switched from a hot-blade to the use of microwave energy, which will effect healing and toe length trimmed. The birds are larger now, which will impact mobility both before and after trimming, and in a consumer-driven trend, the industry is re-examining its codes of practice to ensure the highest level of welfare possible. As there is little pertinent research regarding these changes, the toe trimming procedure was re-examined under modern conditions and with focus on both production and welfare effects to determine if the practice can still be recommended. Hybrid Converter toms were raised to 140 d of age, with half (153) being toe trimmed at the hatchery using a Microwave Claw Processor (MCP) and the other half (153) left with their toes intact. The birds had feed consumption, body weight, mortality, toe length, stance, behaviour, and gait scores monitored throughout the trial with carcass damage assessed at processing. Means were considered significantly different when $P \leq 0.05$. Toe trimming caused a reduction in both feed consumption and body weight in the later stages of the experiment. Final weights for non-toe trimmed and toe trimmed toms were 21.70 kgs and 21.15 kgs, respectively. Feed efficiency with and without being corrected for mortality was unaffected by the procedure. Overall mortality and mortality by age group were also unaffected; however it was found that toe trimmed toms experienced higher levels of rotated tibia at 3.27% versus 0.65% for untrimmed birds.

Toe length measurements found that trimmed toes were, on average, 91.9% the length of an intact toe, and that variability in length increased with trimming. The procedure was not found to impact stance or gait score, although behaviour at all ages measured demonstrated reduced mobility with trimming. In particular, reduced activity in poults for 5 d post-treatment indicates that the MCP treatment caused pain or discomfort. The percentage of carcasses which exhibited scratching was 15.6% for the non-trimmed treatment and 13.3% for the trimmed, which were not significantly different. Also, no significant effect of trimming was found for any other carcass damage category. Based on the negative impacts of toe trimming on both bird production and welfare found in this research, MCP treatment should not be recommended to turkey producers when raising heavy toms.

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1.0 INTRODUCTION

Toe trimming is a common practice in the turkey industry. Its purpose is to remove the claw at the end of the toe in an effort to reduce bird-to-bird scratching and thereby improve carcass grades at processing. Within the literature toe trimming may also be referred to by toe-clipping or de-clawing. The procedure is most commonly completed at the hatchery, within the first day of a poult's life. While historically the toe has been trimmed using either surgical scissors or a cauterizing hot blade, currently the industry uses a Microwave Claw Processor (MCP), technology patented by NovaTech Engineering Inc. (NovaTech Engineering Inc., Willmar, MN 56201; Gorans, 1993). The MCP focuses microwave energy on the distal tissue of a digit, killing the cells and causing the tissue, including the claw, to die and slough off. Most often the three forward facing toes are trimmed, however, all or any combination of the four toes of a poult can be trimmed. Toe trimming has been a common practice in the industry since the 1970's (Marsden, 1971).

There have been very few studies examining the effects of toe trimming on turkeys, and the majority of this research was done 30 to 40 years ago and is no longer representative of current industry practice. In addition to the change to using the MCP, genetic selection has resulted in a faster growing turkey with increased breast muscling (Havenstein et al., 2007). Both the changes in technology and genetics have the potential to change the impact of toe trimming on turkey productivity and welfare.

Animal welfare has been mostly overlooked in past research on toe trimming, due to the time frame in which it was completed. Currently, research on animal production methods places a priority on improving welfare, as concern from both consumers and producers increases. Many historically practiced procedures, such as toe trimming, may no longer be acceptable under current standards and must be examined to determine the welfare implications of maintaining their use.

This thesis focuses on the practice of toe trimming by looking at toe anatomy, the history of its use, the methodologies employed, and past research findings. In addition, it reports research on the use of the MCP method of toe trimming on tom turkey production, including growth, feed efficiency, mortality, and carcass quality, as well as welfare as indicated by scratching, toe histology, bird behaviour, stance, and gait scores.

2.0 LITERATURE REVIEW

2.1 Anatomy of the Toe

The domestic turkey (*Meleagris gallopavo*) has four toes or digits on each foot, three of which are directed to the anterior, and the fourth to the posterior of the bird. The toes are labelled digits I through IV, with the posterior toe being I and digits II III and IV being the anterior toes beginning medially and moving laterally. The skeletal structure of the digits is variable. Digit I is composed of only two phalanges, digit II of three, digit III of four, and digit IV of five phalanges (Lucas and Stettenheim, 1972). The tissue composition of the digits consists of three major layers, the epidermis, the dermis, and the subcutis (Lucas and Stettenheim, 1972; Hodges, 1974) surrounding bone and tendons.

The epidermis is the surface layer of the skin and includes the scales which cover all surfaces of the toe. The epidermis can be further defined, as shown in Figure

2.1. On the very outer surface, exposed to the environment is the stratum corneum. The corneum is composed of dead, tightly packed, keratinized cells, with the outer surface losing cell structure and presenting as laminea (Lucas and Stettenheim, 1972; Hodges, 1974). How densely the keratinized cells are packed determines the surface structure. The outer plate of a scale is very densely packed creating a hard surface, while on the underside of a scale the cells is less dense creating a softer epidermis (Lucas and Stettenheim, 1972). The second layer of the epidermis is the stratum germinativum. This layer lies beneath the corneum and contains nucleated cells, which divide to supply the corneum. Progressing towards the corneum, the stratum germinativum will contain a number of rows of transitional cells (Hodges, 1974). The epidermis contains no vascularisation or innervation, with the exception of feather follicles (Hodges, 1974).

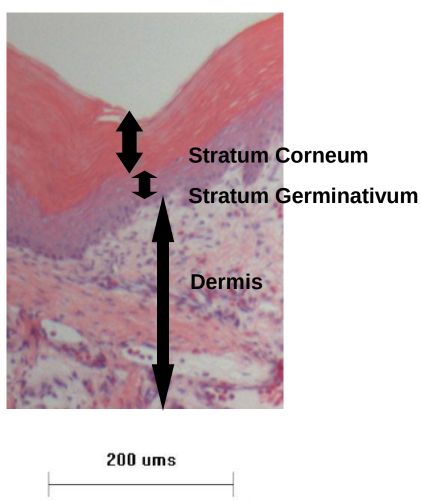

Figure 2.1. Histological representation of the epidermis (stratum corneum and stratum germinativum) and dermis in a turkey toe.

Beneath the epidermis is the dermis, followed by the subcutis, which is connected to the bones and cartilage by elastin and collagen (Lucas and Stettenheim, 1972). The blood vessels and nerves supplying the toes in a turkey are primarily housed within the dermis. This layer consists mostly of collagen to support nerves and blood vessels, although some elastin is found closer to the border with the subcutis (Lucas and Stettenheim, 1972).

The majority of the phalanges are long bones with the shaft consisting of compact bone and the epiphyses containing spongy bone. There are three areas of the long bone which are highly innervated and vascularised. These are the periosteum (a membrane surrounding the bone except for the articulating ends), the endosteum (a membrane lining the marrow cavity), and the bone marrow (McLeod et al., 1964).

Hodges (1974) describes the claw as being formed similarly to a scale, with the epidermis forming papillae in the embryo, after which the cells keratinize to form the hard corneum of both the claws and scales. However, Lucas and Stettenheim (1972) show that the distal phalanges have osseous trabeculae which protrude outward around which the claw is formed. The composition and structure of the epidermis, dermis and subcutis remain very similar to that of the remainder of the toe, except that the dermis and subcutis are thinner over the claw (Lucas and Stettenheim., 1972). Vascularisation and innervation of the claw is through both the dermis and the marrow of the trabeculae, and the level of innervation is extensive (Lucas and Stettenheim, 1972). Most of the dermal nerves and vessels are on the ventral side of the claw, including the primary vein and artery; however, a number of lamellar corpuscles can be found in the dorsal dermis (Lucas and Stettenheim, 1972). Herbst or Meissner corpuscles can be found throughout the skin of the foot, along with other free nerve endings (Hodges, 1974). The extent of innervations seen throughout the length of the digits suggests that any procedure which damages the claw will also cause physical pain.

2.2 Toe Trimming

2.2.1 Historic Usage and Objectives

Current industrial practice is that digits II through IV are trimmed at the hatchery. Literature has shown, however, that many combinations of toes may be considered (Newberry et al., 1992, Kolokol'nikova et al., 2008). The most common technology (MCP), however, is unable to trim Digit I so this digit is often left intact, to reduce the need for the manual labour required to trim it using hot-blade technology. If the trimming is completed within the terminal phalanx of the toe, it allows for complete removal of the trabeculae on which the claw is based without losing tendon attachment to the distal toe. While there are a number of muscles with tendon insertions among the phalanges, only the musculus extensor digitorum longus, musculus flexor digitorum longus, and the musculus flexor perforans (for each digit) have attachments on the distal two phalanges and none have attachment solely on the terminal phalanx (George et al., 1966). Trimming at this point on the digit is thought to allow minimal, if any, regrowth of the nail (Gorans, 1993).

2.2.2 Procedures and Alternate Techniques

Over the past four decades, during which toe trimming has become commonplace, the technologies used for trimming have changed greatly. During the 1970's Marsden (1971) states that trimming should be done using surgical shears. This recommendation was made in preference to the cauterizing hot-blade technique because the latter was considered too slow for commercial use. Surgical shears (usually scissors) cut the toe of a poult, usually the day of hatch, immediately proximal to the base of the claw (Owings et al., 1972; Proudfoot et al., 1979). Use of surgical shears or scissors in research during the 1970's further demonstrates the use of this procedure in the industry (Owings et al., 1972; Proudfoot et al., 1979).

Although the majority of the studies were completed during the 1970's when toe trimming was a novel practice, a study by Newberry (1992) in the 1990's used cauterizing hot-blade trimming rather than the surgical shears, suggesting the industry had moved towards this procedure. This was made possible with the introduction of the automated hot-blade trimmer (Kaniecki, 1977). The hot-blade used in toe trimming is the same as that used in break trimming. The digits of the bird are pushed forward under a red hot blade which is lowered, cutting the digits and held there for a short period of time to allow for proper cauterization before discontinuing contact (Kaniecki, 1977).

2.2.3 Nova-Tech Microwave Claw Processor

Today, the industry primarily uses the Nova-Tech Microwave Claw Processor. It was introduced by Nova-Tech Engineering Inc. in 1993 as an alternative to hot-blade trimming (Gorans, 1993). To treat a poult using the MCP, the poult is first placed into extended shackles (Figure 2.2, A), which then retract into the MCP where the front three toes are slid, using vacuum pressure, into the waveguide chamber (Figure 2.2, B). The MCP has a magnetron (Figure 2.2, C) attached to generate the microwave heat (Figure 2.2, D), which is then guided into the chamber in which the tips of the toes are contained. The microwaves are able to penetrate the tissue of the toe, heating it and killing the cells. The treated tissue becomes necrotic and is sloughed from the end of the toe from one to three weeks post-treatment (Gorans, 1993).

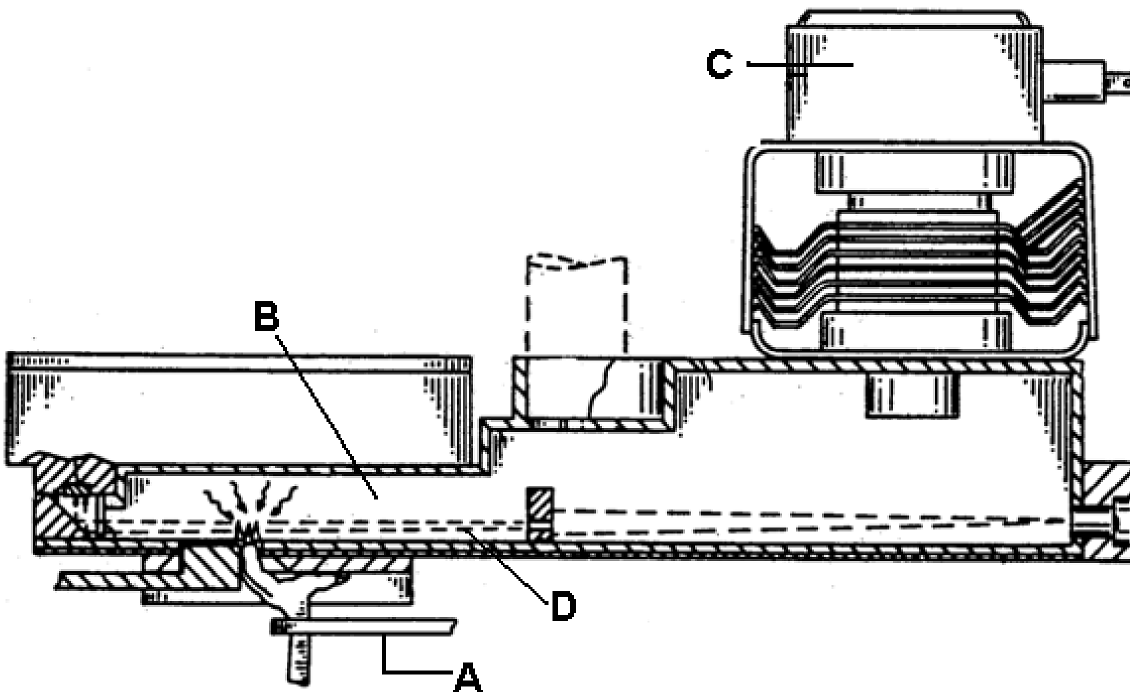

Figure 2.2. The Microwave Claw Processor apparatus. A) Shackles to restrain the poult in an inverted position. B) Waveguide Chamber in which digits are exposed to microwaves. C) Magnetron used to produce the microwave. D) Microwaves guided into a chamber, used to heat toes and kill the exposed cells. (Modified from Gorans, 1993)

The MCP has several possible advantages over the previous method of hot-blade trimming. The first is speed of processing; the machine is capable of processing a poult in under three seconds, with only 0.5 seconds of exposure time needed (Gorans, 1993). The machine requires only one operator to shackle the poult, after which the entire process is automated. This allows the operator to pick up the next poult and shackle it immediately, saving time and manpower. The second advantage is that, according to the inventor, the MCP is able to effectively remove the claw while maintaining the full length of the toe (Gorans, 1993). Using the MCP, the digits of the bird should have only the terminal half of the distal phalanx exposed to the microwaves, this terminal half includes the trabeculae on which the claws are formed. With the hot-blade, however, the cut should be made half way through the second to last phalanx, removing a greater portion of the tissue (Gorans, 1993; Lyon Technologies, Inc., 2006). The final possible advantage of the MCP is that there is no open wound which could act as a portal for bacterial entry. As the exposed tissue takes one week at minimum to be sloughed, this allows the healthy tissue, proximal to the exposed tissue, time to re-form epithelial tissue, which acts as a barrier from the surrounding environment (Gorans, 1993).

2.3 Implications for Production

As well as being an indication of welfare (Fraser, 2003), effects on production variables such as growth, feed efficiency, and mortality will impact the revenue earned by a producer. As the primary purpose of toe trimming is to increase revenue by reducing downgrades, negative side effects of the procedure on production may decrease the economic advantage of toe trimming.

2.3.1 Growth and Feed Efficiency

The effects of toe trimming on production characteristics have not been consistent. Proudfoot et al. (1979), Frank et al. (1990), and Newberry (1992) found that toe trimmed turkeys consumed less and had lower body weights than untrimmed birds, although all three studies varied in the ages where weight differences were found. These studies used either hot-blade or scissors for trimming. Studies completed by Owings et al. (1972), Greene and Eldridge (1975), and Adams et al. (1978) (used scissor trimming), and Fournier et al. (2012) (used MCP), however, found that toe trimming did not affect these production characteristics. All of the above studies found that feed efficiency was not affected by trimming, leaving lower feed consumption responsible for the reduced body weight in trimmed birds. If the birds were eating less, it may indicate that either the trimmed birds were experiencing discomfort or that decreased mobility prevented them from moving freely to and from the feeders. Although feed efficiency remained the same in these studies, extra time needed to reach a target weight due to reduced growth will increase production costs, including utilities, labour, feed, and opportunity costs.

2.3.2 Mortality

Toe trimming poults on the day of hatch may result in higher mortality than those left untreated. Owings et al. (1972) and Newberry (1992) found that trimmed poults had higher early mortality, for the first week and the first four weeks, respectively. Newberry (1992) identified the primary cause of death as starvation, indicating a reduced ability to obtain feed and water, while Owings et al. (1972) did not comment on cause of death. Other studies which monitored mortality found no effect of toe trimming. However, often only total mortality was reported and it is possible differences may have been found if age had been considered (Proudfoot et al., 1979; Frank et al., 1990), particularly within the first weeks after trimming. Fournier et al. (2012) found no difference in mortality due to MCP treatment regardless of age, with no mortality recorded during the first week of age. This may relate to the MCP treatment as both Owings et al. (1972 – surgical shears) and Newberry (1992 – hot-blade) completed their studies using alternate methods.

2.3.3 Carcass Quality and Scratching

The grading regulations in the Canadian poultry industry has three possible grades. Grade A carcasses must have no body parts trimmed, other than the tail and wing tips, and must not be deformed or discoloured. The combined length of all scratches and tears must be less than 1.2 cm on the breast and less than 3.5 cm elsewhere (CFIA, 2012). Birds may be downgraded to utility grade if a carcass does not meet the above requirements for Grade A. Utility Grade will include carcasses with a limb or flesh trimmed, with moderate areas of discolouration, or with dislocated, but not broken limbs. If a carcass exceeds the limits set by utility grade, it becomes Grade C, unless it is condemned (CFIA, 2012). A downgrade from Grade A to Utility grade will result in a deduction of $0.06 CAN/kg for the producer (Rose Olson, Executive Director of the Saskatchewan Turkey Producers Marketing Board, personal communication, January 9, 2013). As all three grades of birds have a similar cost of production, a higher percentage of Grade A carcasses is more profitable.

The toe trimming procedure is used for the purpose of reducing the number of scratches on the carcasses at processing time. However, past studies have been inconsistent in their findings regarding scratching. Proudfoot and colleagues (1979) found no significant improvement in carcass grades with toe trimming. Owings et al. (1972) completed both an experiment and a commercial survey on toe trimming using surgical shears. The experimental research failed to show an effect of trimming on carcass grading, but the survey found moderate success in improving the percentage of birds classified as grade A. The difference in results may be due to the variations between commercial and research barns in both management and set-up. Both the smaller pens with reduced space for flapping and jumping and reduced group numbers in research barns may result in less scratching. Also, research birds often have greater exposure to humans than those in commercial flocks, reducing their fear and the potential of scratching as they flee from fearful stimuli. The different results from research and industry settings suggest that research at the commercial level should be used to confirm results from research institutions before recommendations are made to the turkey industry. Several other studies have also found toe trimming to be successful in reducing carcass scratching (Greene and Eldridge, 1975; McEwen et al., 1992; Fournier et al., 2010).

It is thought that larger birds may be less mobile and therefore less able to scratch pen mates than younger and smaller turkeys. However, this cannot be confirmed from above research as various ages and sexes were found in both those studies that reported no effect of trimming on carcass scratching and those were differences were reported. This does not preclude a body weight effect on scratching in modern turkeys, considering the genetic improvement in growth that has occurred since the majority of research on toe trimming was completed. If there is an effect of body weight on scratching, the effectiveness of toe trimming might still be affected by market age as younger birds are likely still able to inflict scratches due to better mobility. Even if birds are kept to larger ages when mobility and scratching are reduced and carcass grades are not affected, scratching at younger ages will still be a concern regarding pain and fear, as well as possible increased culls. If toe trimming is successful in reducing scratching as some studies indicate, then the procedure may be financially beneficial to the industry (Moran, 1979; McEwen et al., 1992).

The other possible effect of toe trimming on carcass quality is that, if the procedure affects mobility, the bird may spend more time resting on the litter, increasing the risk for breast blisters and aggression from pen mates. While Newberry (1992) did not find an impact of toe treatment on breast blisters, modern toms are larger and have increased breast muscling than the birds she used in her study (Havenstein et al., 2007), which may have an effect on their mobility.

2.4 Welfare Implications

Today's consumers are increasingly concerned about the methods used for food production. This is due to both health concerns, as well as a sense of obligation to ensure the animals whose lives are taken are able to live a happy, natural life (Harper et al., 2002). A survey conducted by the Alberta Livestock and Meat Agency (ALMA) in 2012 found that the younger generation of consumers (18-34 years), especially those with a higher education level, were willing to pay premiums for meat which had qualities they found important; for 29% of the respondents this included paying a premium of over 20% for free range chicken (ALMA, 2012). Because of this increasing concern by both consumers and producers for animal welfare, the poultry industry must consider the pain and stress caused to the birds throughout the production cycle.

The concept of animal welfare is very subjective. With multiple different definitions and adaptations of animal welfare, there are three general ways in which the welfare of an animal can be considered. The first is based on production factors, if an animal is cold, hungry, stressed, etc. it will not perform at the same level as one that has its biological needs met. The second is based on the feelings of the animal, that they should be free from pain, fear and frustration and generally content. The third is that the animals should live in a way which is natural to the species (Fraser, 2003; Hewson, 2003). Very little research has examined the impact of toe trimming on welfare, but it is a physical alteration which has the potential to cause acute pain from the trimming itself, as well as chronic pain due to the presence of neuromas or abnormal gait. Toe trimming may impact productivity, prevent natural behaviours due to reduced mobility, and is not natural for the species, thereby potentially violating all three views of welfare, and so needs to be evaluated for both what it adds to the welfare of the bird as well as how it detracts from it.

2.4.1 Arguments for Toe Trimming Improving Welfare

As discussed above, increased carcass scratching is a concern if leaving toes intact. If toe trimming does reduce scratching, then leaving toes intact will cause scratches which could have been avoided. While the skin of poultry is thought to be less sensitive than the skin of mammals based on the innervation present, it is still vascularised and innervated especially within feather follicles (Flammer, 2007). It can therefore be assumed that any scratch which reaches as deep as the dermis, where vessels and nerves are located, would cause pain.

The healing process of a laceration includes several stages: haemostasis, inflammation, tissue generation and revascularization, wound contraction, and maturation (Singer et al., 1999; Hosgood, 2006). The open wound caused by a scratch could also be a portal for bacteria until the wound is re-epithelialized. This may only take one or two days for a shallow or sutured scratch, but if scratching is severe or if there is tearing involved, it will take four days for re-epithelialisation just to begin after which the size and location of the scratch will determine healing time (Singer et al., 1999; Hosgood, 2006). While the wound will likely not cause pain for an extended period of time, it can be assumed there will be about three days of discomfort during the inflammation stage. If toe trimming is successful in reducing scratching, the reduction in pain and stress must be considered when examining its effect on welfare.

According to the feelings-based approach, the stress a bird is under must also be considered when looking at welfare. Two studies on toe trimming in Leghorn hens have found that that toe trimmed birds have reduced fear and stress as compared to those which were not trimmed (Compton et al., 1981; Honaker et al., 2004). As turkey flocks are raised in an intensive environment, stress caused from the risk of aggression and scratching may be higher in birds which are not trimmed. Also, regular checks of the barns are required by producers and so reduced fear of handlers in trimmed birds, as found in the study by Honaker et al. (2004), would make these checks less stressful for the flock and the animal attendant.

2.4.2 Arguments for Toe Trimming to Reduce Welfare

2.4.2.1 Pain

The most obvious concern with toe trimming is the pain caused directly from the procedure as well as any chronic pain which may result from it. While the studies looking at toe trimming in turkeys primarily focused on production variables, Owings et al. (1972) noted that poults toe trimmed with surgical shears showed reduced activity in the first three d post treatment. Fournier et al. (2012) also found that MCP trimmed poults walked and stood less on d three after treatment, preferring to sit or rest instead. These findings indicate that toe trimming with either method does cause short term discomfort or pain. The study by Fournier et al. (2012) continued to look at behaviour later in the life of the turkeys to see if long term or chronic pain was an issue. No differences in behaviour between treatments were found suggesting no long term effects. The appearance of chronic pain due to toe trimming may be less than that seen in beak trimming, as amputated toes show better regeneration and tend to form fewer and less complex neuromas (Gentle et al., 1988), although this has not been examined with the use of the MCP.

2.4.2.2 Balance and Mobility

The growth rate and exaggerated breast muscle yield in modern turkeys, already compromises the mobility of the birds (Paxton et al., 2013). Therefore it is conceivable that the removal of some of the toe length through trimming could decrease the bird's ability to move with a natural gait. Furthermore, this may result in the bird being unable to move freely to drinkers and feeders, or to escape from aggressors. While Fournier et al. (2012) did not find a difference in gait or behaviour in turkey hens while using the same methods as the current study, gait was measured on week 7, and behaviour studied up to week 13. The difference in body and breast muscle weight between 13 week hens and older heavy toms is significant (Hybrid Turkeys, 2011 - "Body weight performance goals") and therefore toms may experience a greater impact of trimming on mobility at older ages.

2.4.2.3 Risk of Infection

As previously mentioned, toe trimming with the MCP allows the claw to be removed without an open wound exposed to the environment (Gorans, 1993). A case study of an outbreak of *Staphylococcus aureus* in a turkey flock, however, indicated that toes which had been microwave treated had served as a portal for the bacteria (Alfonso et al., 2006). This may have been due to operational error of the MCP, and so not a common occurrence, but it does emphasise the importance of proper training, sanitation and quality control at the hatchery.

2.5 Conclusions and Research Objectives

The historic and lengthy use of toe trimming indicates that it likely was, and may still be, a useful tool for the industry. However, research reviewing the procedure is minimal and mostly quite old despite important changes in the technology being used (introduction of MCP) and the nature of the turkey itself. Genetic selection has and continues to change the turkey phenotype with modern birds having much faster growth and increased muscling (Havenstein et al., 2007), and industry now commonly produces a larger turkey at marketing. These changes may impact the effect of toe trimming on production and carcass characteristics as well as bird welfare. Changes in growth patterns, as well as the switch to the MCP, means that much of the literature available on toe trimming is no longer applicable to the industry.

The current study was proposed to re-examine the toe trimming procedure under modern conditions. It will address effects of toe trimming on production as well as welfare, which is a focus lacking in older studies.

3.0 THE EFFECT OF TOE TRIMMING ON PRODUCTION CHARACTERISTICS OF HEAVY TURKEY TOMS

3.1 Abstract

Trimming the three anterior toes on both feet at day of hatch to remove the claws, reduce bird scratching and improve carcass grades is a common practice in the turkey industry. Changes in the method of trimming and the growth potential of turkeys since the majority of research on this topic was completed motivated this study with the objective of establishing the effects of microwave toe treatment on the production characteristics of tom turkeys. Turkey toms (306 in total) were either toe trimmed at the hatchery using a Microwave Claw Processor (T) or were sham treated only (NT). Poults were randomly assigned to one of nine replicate pens for each treatment. Average body weight, feed consumption, and feed efficiency were determined from body weight and feed intake measured by pen on d 0, 7, 21, 42, 56, 70, 91, 126, 140. On d 140, toms were sent to a commercial processing facility where five carcasses from each pen were examined for scratching and other externally visible damage. Average body weight was higher for NT toms on d 91, 126, and 140 ($P \leq 0.05$), with final weights of 21.70 kg and 21.15 kg for NT and T treatments, respectively. Trimmed birds had lower feed consumption than their NT counterparts during the first and last week of production ($P \leq 0.05$), but feed efficiency was unaffected. Carcass scratching (T 13.3% vs NT 15.6%) and other carcass damages were not affected by treatment. While overall mortality was not affected by treatment, the incidence of mortality due to skeletal causes, especially rotated tibiae, was increased in T toms ($P \leq 0.05$). Negative effects

on performance and no impact on carcass quality suggest that toe trimming may not be required or recommended for heavy tom turkeys.

3.2 Introduction

Carcasses of turkeys raised in Canada are graded for quality characteristics. Lower grades have reduced value to compensate for additional costs of processing and the decreased product value. Carcass scratching is an important reason for downgrading, with scratches as short as 1.2 cm in length resulting in a reduced carcass grade (CFIA, 2012). To prevent excessive downgrades from scratching, the turkey industry has employed the practice of toe trimming, in which the claws on the three anterior-facing digits on the feet are removed. This is generally done at the hatchery, historically using surgical shears or a hot-blade cauterizing technique, but more recently using a Microwave Claw Processor (MCP) (NovaTech Engineering Inc., Willmar, MN 56201). The latter process was introduced to the turkey industry in 1993 (Gorans, 1993) and has become the predominant technique since its introduction.

Past research on the impact of toe trimming has been inconsistent and some reports have suggested negative production effects. While some research, primarily using hot-blade removal or surgical scissors, found that toe trimming prevented carcass scratching (Owings et al., 1972; Greene and Eldridge, 1975; Moran, 1979), other research did not (Owings et al., 1972; Proudfoot et al., 1979). Toe trimming also did not affect the incidence of breast blisters, a carcass quality parameter that could be affected if toe trimmed birds are less mobile (Newberry, 1992). Reduced body weight and feed consumption as a result of toe trimming is a common finding, but feed efficiency is unaffected by treatment (Proudfoot et al., 1979; Frank et al., 1990; Newberry, 1992).

While overall mortality did not differ based on toe treatment, a higher mortality level was found for T poults during the early brooding period than their NT counterparts (Owings et al., 1972; Newberry, 1992). In a recent study, MCP toe treatment in turkey hens found no impact on mortality, body weight, feed consumption, feed efficiency or mortality, but found a reduction in carcass scratching with toe trimming, leading to a favourable recommendation for the procedure (Fournier et al., 2012).

The relevance of older toe trimming research may be questioned, particularly because of the change in trimming technique and the increased growth and meat yield of turkeys. The MCP technique treats the toe claw and results in its loss one to three weeks post treatment, in comparison to the hot-blade technique, which removes the tissue immediately. It is possible that the changes in technique could change pain associated with the treatment, as well as the healing process, and the amount of toe removed. The fact that turkeys grow rapidly with larger weights at marketing and higher breast meat yield is readily seen and has been documented (Havenstein et al., 2007). These changes may alter bird mobility, thereby limiting the occurrence of scratching, even if the claws are left intact. It could also be argued that larger birds with increased breast muscling may have reduced balance, a factor made worse by the shorter toes associated with toe trimming. While MCP treatment of hens has been studied (Fournier et al., 2012), examining the procedure using heavy toms, which are marketed at older ages and heavier weights will aid in the understanding of the procedure in birds different in gender as well as age and size at marketing.

Concern for animal welfare has also increased since the majority of toe trimming research was completed. Procedures perceived to be painful are being examined to determine if they are necessary, and if they are appropriate from a welfare perspective. Earlier studies on toe trimming failed to examine the effect of toe trimming in regards to welfare criteria. Because of the changes in method, turkey phenotype and animal welfare emphasis, the current study was completed to examine the effect of toe trimming on the production characteristics and welfare of tom turkeys reared to 20 week of age.

3.3 Materials and Methods

All birds were raised according to the recommendations of the Canadian Council of Animal Care (1993) and experimental procedures approved by the University of Saskatchewan's Animal Care Committee (Protocol UCACS 19940248).

3.3.1 Birds, Housing, and Care

The study used 306 Hybrid Converter turkey toms acquired from a commercial hatchery, where they were vent sexed, beak treated (IR trimmed) and vaccinated, then placed on the MCP. One half of the poults (153) had the three anterior toes on both feet treated at the hatchery using the MCP set at 1.26 seconds of exposure and toe length set at 59% trim (T). The % trim setting is measured based on the difference in light emitted from one side of the waveguide chamber (Figure 2.2) and what is detected on the other side, with the amount of toe inserted responsible for blocking the remainder of the light. Both settings were considered normal (Nova-Tech Engineering, Inc., 2011). The remaining birds were sham treated on the MCP machine (NT). At the research facility, poults were randomly housed in one of eighteen 3 x 3 m pens. Seventeen poults were assigned per pen with an anticipated final stocking density of 34 kg/m^2 based on an expected weight of 19.9 kg (Hybrid Turkeys, 2011 - "Body weight performance goals”) and a 10% mortality rate. On d 1 poor poults from trial pens of both T and NT were switched for spare poults of the same treatment which were larger and stronger.

Room temperature was maintained at 30°C with supplemental heat provided by one 175 watt heat lamp in each pen. Starting on d 13, the temperature was gradually decreased to 22°C by d 35 and subsequently to 17°C by d 91. Cardboard brooder rings were used for the first nine days and wood shavings were spread on top of the straw litter within the cardboard ring. Additional straw was added equally to the litter in each pen as required during the remainder of the experimental period. Light, from incandescent bulbs, was provided as detailed in Table 3.1. Reducing light intensity below 10 lux was done to reduce tom aggression.

Table 3.1. Intensity and duration of light provided for toms

Day of age	Day length (light hrs:dark hrs)	Intensity (lux)
0-9	23:1	22
10-26	18:6	10
27-32	18:6	3
33-97	18:6	2
98-140	18:6	0.7

The toms were fed ad libitum, using a six step diet feeding program purchased from a commercial feed mill. The nutritional specifications for the six diets matched or exceeded those specified for Hybrid Converter Tom turkeys (Hybrid Turkeys, 2011 - “Nutritional guidelines”; Appendix 1). Two aluminum tube feeders were used in each pen. From 0-89 d the diameter of each feeder was 38.1 cm while from 89 d to market the diameter of each feeder was 40.6 cm. Water was also provided ad libitum and was supplied using one bell drinker (45.7 cm in diameter) per pen; an additional water source was supplied for the first 11 days (21.6 cm in diameter). The toms were kept to 140 d of age.

3.3.2 Data Collection

Body weight and feed intake were measured on a pen basis on d 0, 7, 21, 42, 56, 70, 91, 126, and 140. From these values, growth rate, feed consumption, and feed efficiency were determined. Dead birds and culls were weighed and recorded daily, after which they were necropsied at Prairie Diagnostic Services in Saskatoon, SK to determine cause of death. On d 140 the toms were shipped to a commercial processing plant. Immediately after evisceration, five carcasses per pen (45 carcasses per treatment) were weighed and damage to the carcass was measured and recorded. Damages recorded included scratching, breast blisters, bruising, broken bones, and any other marks observed. Damage caused by the equipment at the plant was not included in the observations.

3.3.3 Statistical Analysis

The experiment was conducted as a one-way analysis of variance, with two toe treatments, in a completely randomized design. Each treatment was replicated nine times. The data were analyzed using the Mixed Model of Statistical Analysis System 9.2 (Statistical Analysis Systems Institute, 2002). Data were tested for normal distribution using Proc Univariate, and (log+1) transformed when necessary. Treatment comparisons were considered significantly different when $P \leq 0.05$.

3.4 Results and Discussion

3.4.1. Body Weight, Feed Consumption, and Feed Efficiency

Toms not trimmed at the hatchery (NT) were heavier than T birds from d 91 onward (Table 3.2). Weight gains were higher for NT toms from d 70 to d 126, resulting in increased overall gains for the 140 d period (Table 3.3). Trimmed birds consumed less feed than the NT birds from 0-7 and 127-140 d of age (Table 3.4). The change in feed intake corresponded to body weight differences and likely caused the reduction in body weight in T birds. Feed efficiency, analyzed both with and without mortality correction, was not affected by toe treatment (Table 3.5, correction for mortality not shown).

Table 3.2. Effect of toe trimming on average body weight (kg)

Days of age	Trimmed	Non-Trimmed	SEM[2]
0	0.06[1]	0.06	0.001
7	0.15	0.16	0.003
21	0.69	0.70	0.009
42	2.83	2.85	0.032
56	5.06	5.08	0.042
70	7.72	7.84	0.064
91	11.93[b]	12.23[a]	0.089
126	18.88[b]	19.47[a]	0.091
140	21.15[b]	21.70[a]	0.085

[1] Each value represents the mean of 9 replicate pens.
[a,b] Treatment means with different letters are significantly different ($P<0.05$).
[2] SEM – pooled standard error of the mean.

These results are in general agreement with the scientific literature despite the use of alternate toe trimming techniques in the previous work. Newberry, using the hot-blade technique, (1992) raised toms to 17 week and found NT birds were heavier at 4, 12, and 17 week of age and consumed more feed during those same periods. Owings et al. (1972) examined the effects of trimming toes with surgical scissors in a controlled experiment as well as completing a corresponding survey of commercial processing plants. They found feed efficiency was unaffected and body weight was equal or improved in NT birds in the survey, but no difference in body weight was seen in the experiment. Proudfoot et al. (1979) (using surgical scissors) studied both genders and found that trimming did not affect efficiency, but reduced body weight when turkeys were marketed at 98 d. Frank et al. (1990) did not measure feed consumption, but found lower body weight in T toms at 133 d of age. Greene and Eldridge (1975) (using a hot-blade) did not find any effect of toe trimming on the body weight of hens. The only study examining the effects of the microwave toe treatment did not find any difference in body weight, feed consumption, or feed efficiency in hens raised to 15 week of age (Fournier et al., 2012). The research suggests that regardless of technique, feed consumption and therefore body weight, can be negatively impacted by trimming. There also appears to be a gender effect, as studies using hens did not show this effect (Greene and Eldridge, 1975; Fournier et al., 2012). This may be due to differences in size and age at marketing, although behavioural differences between toms and hens can't be ruled out.

Table 3.3. Effect of toe trimming on average weight gain (kg)

Age (d)	Trimmed	Non-Trimmed	SEM[2]
0-7	0.09[1]	0.10	0.003
7-21	0.54	0.54	0.008
21-42	2.14	2.15	0.026
42-56	2.23	2.24	0.024
56-70	2.66	2.75	0.033
70-91	4.21[b]	4.39[a]	0.042
91-126	6.95[b]	7.24[a]	0.038
126-140	2.28	2.23	0.060
Overall	21.09[b]	21.65[a]	0.085

[1] Each value represents the mean of 9 replicate pens.
[a,b] Treatment means with different letters are significantly different (P<0.05).
[2] SEM – pooled standard error of the mean.

Table 3.4. Effect of toe trimming on average feed consumption (kg)

Days of age	Trimmed	Non-Trimmed	SEM[2]
0-7	0.12[b,1]	0.13[a]	0.003
7-21	0.69	0.70	0.011
21-42	3.30	3.31	0.046
42-56	4.08	4.11	0.067
56-70	5.38	5.61	0.083
70-91	10.49	10.81	0.142
91-126	19.59	19.92	0.193
126-140	8.42[b]	8.85[a]	0.094
0-140	52.44	53.44	0.464

[1] Each value represents the mean of 9 replicate pens.
[a,b] Treatment means with different letters are significantly different (P<0.05).
[2] SEM – pooled standard error of the mean.

Table 3.5. Effect of toe trimming on gain:feed ratio

Days of age	Trimmed	Non-Trimmed	SEM[2]
0-7	0.745[1]	0.722	0.0162
7-21	0.778	0.765	0.0124
21-42	0.649	0.648	0.0076
42-56	0.547	0.544	0.0104
56-70	0.475	0.472	0.0091
70-91	0.392	0.390	0.0093
91-126	0.325	0.345	0.0105
126-140	0.234	0.236	0.0135
0-140	0.389	0.393	0.0053

[1] Each value represents the mean of 9 replicate pens.
[a,b] Treatment means with different letters are significantly different ($P<0.05$).
[2] SEM – pooled standard error of the mean.

The reduced growth later in this study may reflect a reduced ability or motivation of the T toms to walk to feeders and waterers. Since growth is reduced after equal growth during earlier parts of this experiment, it suggests that this change is not associated with pain.   An alternative explanation is that trimmed birds have poorer balance because of the shortened toes. As the research pens were small, if the T birds are finding it more difficult to walk to the feeders, a commercial setting may exacerbate the problem as feeders are further apart. It is noteworthy that toe trimming treatment did not affect bird gait or stance, which would be contradictory to this argument (Chapter 4). Behaviour analysis at 133 d of age, however, demonstrated T toms walked less and stood more than the NT treatment (Chapter 4), indicating a reluctance to move. The differences in feed consumption during the first week were likely the result of the pain and/or stress caused by the procedure. Data discussed later in this thesis found that MCP trimmed poults rested more, and ate, stood, walked, and ran less during the first five d post-treatment, which is in agreement with this logic (Chapter 4).

3.4.2. Mortality

Higher than expected mortality occurred in the study, but toe trimming treatment did not affect overall death and culling loss. Total mortality was 17.0% for the T treatment and 13.1% for the NT. However, the mortality in the first week of production showed a trend (P=0.10) towards increased T poult mortality, with 3.92% and 0.65% mortality for T and NT poults, respectively (Table 3.6). Early poult mortality was of particular interest as several other studies, using alternate methods, found toe trimming increased death loss (Owings et al., 1972; Newberry, 1992). Newberry (1992) found that starvation in the first four weeks was higher in toe trimmed poults. Fournier et al. (2012) found no difference in poult mortality when trimmed using the MCP. In the current research, yolk sac infection mortality in the first week was primarily responsible for the difference in treatment means. While starve-outs or dehydration would logically be the most affected by toe trimming, yolk sac infection could be an indication of bacteria entry through open wounds in the toes. One of the suggested attributes of the MCP is the absence of an open wound, therefore discouraging bacterial infection. Bacterial colonies, however, were found in tissue samples of the toes on day of trimming (Chapter 4), and blood was seen on the shavings at placement, indicating bacterial entry is possible. Two case studies have noted bacterial infection in young poults, where MCP treatment was thought to be the entry portal, indicating inappropriate MCP settings and protocol as probable causes (Hollifield et al., 2000; Alfonso and

Barnes, 2006). Based on the timing of the peak in yolk sac infection mortality (d 3), it is more probable that the infection would have initiated before the trimming occurred and the high mortality in T poults was a coincidence.

Causes of death were summarized into one of four categories (Skeletal, Metabolic, Infectious, Other) for statistical analysis, as well as being analyzed individually. Table 3.7 defines the causes of death included in each of the categories. There were increased culls due to skeletal issues in the T toms as compared to the NT birds (Table 3.8), primarily due to an increase in cases of rotated tibia (3.27% vs. 0.65%). It is possible the lack of toenails reduced the traction of T birds causing slippage, which may have damaged the joints of the leg. In contrast, Newberry (1992) found that toe trimming had no effect on “twisted legs”, however, the toms in this study had only digits II and III trimmed, leaving the outer digit intact and possibly providing traction that prevented rotation of the lower leg. Another explanation could be that tendon damage occurred during placement on the MCP equipment, however, this potential mechanism does not seem plausible since the NT poults were sham treated and experienced the same procedure except for the microwave exposure. Fournier et al. (2012) used MCP to trim turkey hens and found no effect of trimming on rotated tibiae.

Table 3.6. Effect of toe trimming on incidence of mortality (%)

Days of age	Trimmed	Non-Trimmed	SEM[2]
0-7	3.92[1]	0.65	0.240
7-21	3.92	4.58	0.269
21-42	0.65	0.00	0.107
42-56	0.00	0.65	0.107
56-70	1.96	1.96	0.221
70-91	1.31	1.96	0.212
91-126	3.92	2.61	0.264
126-140	1.31	0.65	0.174
0-140	16.99	13.07	0.137

[1] Each value represents the mean of 9 replicate pens.
[a,b] Treatment means with different letters are significantly different ($P \leq 0.05$).
[2] SEM – pooled standard error of the mean.

Table 3.7. Categories used in cause of death analysis.

Skeletal	Metabolic	Infectious	Other
Broken leg	Round heart	Enteritis	Dehydration
Broken wing	Ascites	Yolk sac infection	Pendulous crop
Ruptured tendon	Ruptured aorta	Air sac infection	Aggression
Rotated Tibia		Tenosynovitis	Runt
			Haemorrhage

Table 3.8. Effect of toe trimming on the cause of mortality (%)

	Trimmed	Non-Trimmed	SEM[2]
Skeletal	5.23[a, 1]	1.31[b]	0.9772
Metabolic	0.65	3.27	0.9511
Infectious	5.23	1.96	0.9675
Other	5.88	5.88	1.4267

[1] Each value represents the mean of 9 replicate pens.
[a,b] Treatment means with different letters are significantly different (P<0.05).
[2] SEM – pooled standard error of the mean.

3.4.3. Carcass Damage

A summary of carcass damage assessed at processing is shown in Table 3.9. Toe trimming did not affect carcass scratching, with 13.3 and 15.6% of carcasses scratched for the T and NT birds, respectively. Similarly, no differences were found between treatments for other carcass damage categories. This finding is contrary to previous research where toe trimming decreased carcass scratching (Owings et al., 1972; Greene and Eldridge, 1975; Fournier et al., 2012). While it is not possible to determine the reasons for the difference in results, as many factors may be influencing carcass scratching, the low incidence of scratching in the present study for both T and NT birds suggests that there was a reduced predisposition to scratching in heavy tom turkeys as compared to the flocks previously studied. This reduction could relate to gender differences in behaviour or differences in body weight. The current research used heavy toms raised to an older age, while most previous studies used lighter birds or hens that may have been more mobile and capable of scratching pen mates.

In the report by Owing et al. (1972), toe trimming improved carcass grades in the commercial plant survey, but did not affect scratching in the experimental component of the research. The difference in results between the research experiment and the commercial survey indicate that the differences in housing and care between a research and commercial barn may have an effect. For this reason studying the procedure at the commercial level will be important for future work.

Table 3.9. Effect of toe trimming on carcass damage (%)

Carcass trait	Trimmed	Non-Trimmed	SEM[2]
Scratching	13.33[1]	15.56	3.154
Bruising	31.11	35.56	5.830
Breast Blisters/Buttons	37.78	33.33	4.444
Broken leg	2.22	2.22	1.524
Broken wing	15.56	6.67	2.902

[1] Each value represents the mean of 9 replicate pens.
[a,b] Treatment means with different letters are significantly different ($P<0.05$).
[2] SEM – pooled standard error of the mean.

It was hypothesized that toe trimming would reduce bird mobility, resulting in greater litter contact and a higher incidence of breast blisters. Newberry (1992) looked for differences in the incidence of breast blisters and, like the current study, found no difference between T and NT treatments. This suggests that trimming does not increase the risk of blisters; however, results may be affected by severity of trimming or litter quality.

3.5 Conclusions

Toe trimming demonstrated no positive effect on carcass quality and had negative effects on body weight, feed consumption, and the incidence of rotated tibiae.

No other effects of trimming on tom turkey production were noted. As the purpose of the procedure is to reduce carcass scratching, and was unsuccessful in doing so, the additional costs of labour and machine use due to trimming would not be compensated for by increased product value. In addition, the reduction seen in final body weight with toe trimming is likely to be an economic loss for the producer.

The hypothesis of reduced scratching and maintained productivity with toe trimming was rejected, likely due to differences in the size of the turkeys compared to those previously studied. It should be emphasized, however, that these results apply solely to the heavy tom market, as previous studies have indicated benefits with trimming in other turkey market categories. There is a need for further research in industry to confirm the effects on tom trimming at a commercial level and to determine the market categories where toe trimming is a useful tool. Due to the economic loss in terms of kilograms of poultry produced, as well as the cost of the procedure, based on the results of the current study toe trimming is not recommended for use on heavy toms.

4.0 THE EFFECT OF TOE TRIMMING ON TOE LENGTH, BEHAVIOUR, MOBILITY, AND OTHER INDICATORS OF WELFARE IN TOM TURKEYS

4.1 Abstract

Society is increasingly concerned about the welfare of animals kept for food production; therefore, invasive procedures such as toe trimming in turkeys should be studied to assess their welfare implications to ensure they are acceptable for continued use. Research was completed to evaluate the welfare effects of toe trimming on toms raised to 140 d of age. The study used 306 Hybrid Converter toms, half of which were toe trimmed using a Microwave Claw Processor (T) and half that were sham treated (NT) but not trimmed. Turkey behaviour was observed on d one, three, five, and 133. Toe samples were taken every second day for 14 days after treatment and were used to histologically examine the healing process. Toe length, gait score, and bird stance were assessed on d 55, 84, 119, and 139. For the first 5 days after treatment, T birds demonstrated less active behaviours such as feeding, standing, walking and running, indicative of discomfort or pain with the effect diminishing with age. At 133 d, T turkeys stood more and walked less than NT birds. Gait score and bird stance were not affected by treatment. The trimmed toes were on average 91.9% of the length of untrimmed toes and toe length was more variable as a result of the trimming process. Histological examination of toe samples indicated trimmed toes had complete epithelium closure over the healthy tissue by d eight and were fully healed by d 14. The behaviour and histology results demonstrate a short term welfare risk for trimmed poults after

treatment, with behaviour at 133 d suggesting a long term impact on bird mobility. However, stance and gait score data do not suggest chronic pain is a concern.

4.2 Introduction

Knowledge of the intensification of the livestock production systems, increased disposable income, as well as an increasingly urban population with reduced contact with agriculture, has heightened consumer concern for animal welfare and has encouraged animal industries and governments to establish policies or legislation on the production of food animals (Napolitano et al., 2010). In Canada, government and industry work to develop codes of practice used to establish guidelines on acceptable animal production. These codes are not enforced, but can be used as a guide to judge the acceptability of poultry production. The poultry marketing boards (i.e. Turkey Farmers of Canada) are currently developing their own recommendations based on these codes, which will be enforced through auditing programs run by their respective organizations. Regarding toe trimming and other surgical alterations, the current codes state that they “should be avoided except when it is necessary to prevent either self-inflicted injury or injuries to others in later stages” (Canadian Agri-food Research Council, 2003). Due to the out-dated nature of past studies, it is important to re-examine toe trimming to determine its effect on bird welfare and if it is still acceptable under these codes.

Previous studies looking at toe trimming on turkeys have focused on production effects, rather than the procedure’s impact on bird welfare. Carcass scratching has been a focus of many of the studies, and although discussed in economic terms, scratching is a welfare concern as well because of bird pain and stress. Several studies have found decreased scratching with toe trimming suggesting a benefit in long term welfare (Owings et al., 1972; McEwen et al., 1992). Fournier et al. (2012) examined the welfare implications in hens of trimming with the Microwave Claw Processor (MCP). They found that while behaviour suggested short term pain due to the procedure, the reduction in scratches at processing was large, and mobility and other long term behaviour criteria were unaffected. As a result, trimming was suggested to be beneficial to bird welfare.

No research has been published on the impact of MCP treatment on the welfare of tom turkeys. The larger weights of toms as compared to hens at marketing may reduce bird mobility and subsequent scratching. Furthermore, toe shortening in larger toms may have a larger impact on balance or posture than for hens. Finally, toms may differ inherently in behaviours associated with scratching. Therefore, the objective of the current study was to determine the impact of MCP toe trimming on bird welfare as assessed by examining the behaviour, mobility, toe healing, toe lengths, and posture of tom turkeys kept to 140 d of age.

4.3 Materials and Methods

The standards set by the Canadian Council of Animal Care (1993) were followed and approval for all procedures was received from the University of Saskatchewan's Animal Care Committee (Protocol UCACS 19940248).

4.3.1 Birds, Housing, and Care

The welfare indicators reported in this paper were measured concurrently with the production response criteria reported elsewhere (Chapter 3). A total of 306 Hybrid Converter tom poults purchased from a commercial hatchery (Lilydale hatchery, 7503

127 Ave NW, Edmonton, AB) (153 treated (T) using the MCP set at 1.26 sec of exposure and toe length at 59% trim (61% of guide light is blocked by the inserted toe length), and 153 sham treated (NT)) were randomly assigned 3 X 3 m floor pens within a common barn (nine per treatment; 17 poults per pen for a final stocking density of 34kg/m^2). All toms were given ad libitum water from one bell drinker and commercial feed from two tube feeders; feed was provided in a six-step dietary program meeting or exceeding recommended nutrient specifications (Hybrid Turkeys, 2011 - “Nutritional Guidelines”; Appendix 1). Poults were given 23 h of light at 22 lux intensity from placement to 9 d of age. Day length was then reduced to 18 h and light intensity to 10 lux. Due to aggression, light intensity was further reduced to 0.7 lux by 98 d as described in detail in section 3.3.1 of this thesis. Barn temperature was set at 30°C for 13 d, after which it was gradually decreased until reaching 17°C at 91 d. A heat lamp (175 watt), supplemental drinkers and feeders and a cardboard ring were included in each pen for the first nine d. An additional 42 birds were kept in two spare pens for tissue collection.

4.3.2 Data Collection

Behaviour was assessed using instantaneous scan sampling at several times throughout the trial (Altmann, 1974). On d one, three, and five after treatment, scan sampling was done for ten min for each of the 18 pens with one observation made per min. This was done by a single observer seated beside the pen, with recording beginning after five min of acclimatization. At the start of each minute, behaviours being performed by only one or two birds were noted first while behaviours being performed by a number of birds were last to be counted. All behaviours observed were mutually exclusive, with one behaviour recorded per poult per scan.

Behaviour was also examined at 133 d of age. Birds were observed over a 24 h period, which was made possible by the use of a ceiling mounted infrared camera (TVR Digital Video Recorder version 2.20, American Dynamics, Boca Raton, Florida, U.S.A.) in each of the trial pens. All 18 pens were recorded over the same 24 h. Videos were reviewed (VLC media player 2.0.1, VideoLAN, Paris, France) later, again using the scan sampling technique, with observations made every 30 min from each pen. Every observed behaviour was recorded by pen at each sample moment (Table 4.1).

Bird mobility was assessed on d 55, 84, 119, and 139 using the gait scoring method of Nestor et al. (1985). Birds were categorized on a scale from zero to four, with zero being no defect in the gait and four being an inability to walk. Five toms were randomly selected from every pen on d 55 and wing banded for identification. At each age, these birds were individually weighed, gait scored, and the length of digits II, III, and IV on both feet were measured from the metatarsal-phalangeal joint to the most distal edge of the toe (not including the claw) using digital callipers (Figure 4.1). The five toms were also photographed from a side-profile in a natural stance and from this photo the angle of the breast in relationship to the horizontal plane was measured. This was done by drawing a horizontal line through the point where the breast meets the leg, and a line from that point following the line of the breast (Figure 4.2). Bird stance was measured to assess if toe trimming affects bird centre of balance. If a selected bird died during the trial, another from the pen was randomly selected to replace it. This occurred on five occasions throughout the trial.

Table 4.1. Description of observed behaviours

Behaviour	Description
Resting	Legs are bent beneath the bird and the body is resting on the ground. Head on the ground or resting against the chest. Very little movement, the bird appears to be sleeping.
Sitting	The feet are curled beneath the bird and the body is resting on the ground. The head is up and the bird appears alert.
Standing	Both feet are in place on the floor and the legs are erect. None of the other described behaviours are being performed.
Walking	In the process of taking a step in any direction, while not engaged in other described behaviours.
Run	Moving quickly across the pen, with no hesitation between steps.
At feeder	The bird is pecking at the feed and appears to be eating.
At drinker	The bird is focused on the water, either with beak in the water or pausing in between dips into the water.
Strutting	Back and tail feathers are erect, snood is extended and wings are dropped.
Preening	Use of the beak to clean and condition feathers.
Litter pecking	Pecking or sorting through the litter.
Stretching	A leg or wing is extended fully out with constant force for several seconds with the apparent purpose of stretching the muscles.
Head shaking	The head is moved side to side rapidly.
Object pecking	Pecking at inanimate objects within the pen, other than the litter.
Feather pecking	Pecking at the feathers of another bird, whether aggressive or not.

Figure 4.1. Technique used for measuring toe length.

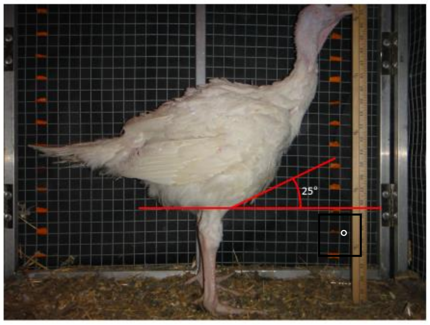

Figure 4.2. Technique used to evaluate bird stance. The angle between the two lines is measured.

Four T poults and two NT poults sampled from the spare pens were euthanized every other day, beginning on d 0 and ending on d 14. The right foot was removed from each poult and stored in 10% neutral buffered formalin. Digits II through IV were later removed from the foot, sectioned onto slides, stained with haematoxylin and eosin dye, and subsequently used to study toe healing after the MCP procedure. After the trial, because of observations found in the histology slides, X-rays were performed on a foot of two 18 week turkeys with different levels of trimming to examine bone structure.

4.3.3 Statistical Analysis

The data were analyzed as a one-way ANOVA using the mixed model in SAS (2002). Repeated measures analysis was used to evaluate the effects of treatment and time on stance and gait. Correlations between gait score, body weight or toe length (analyzed by digit) were determined using Proc Corr within each day of collection. All data were checked for normality using Proc Univariate, with abnormally distributed data (behaviour) being log transformed. Differences were considered significant when $P \leq 0.05$.

4.4 Results and Discussion

4.4.1 Toe Length and Variability

Toe lengths were measured throughout the trial to assess both the severity and consistency of the amount of toe trimmed (Table 4.2). At 140 d of age the mean toe length of the three trimmed toes was 63.6 mm compared to a mean length of 69.3 mm in the NT toms, resulting in a trimmed toe being on average 91.9% the length of an intact toe. While these measurements do not support the claims made in the patent that trimmed birds are able to maintain the full length of their toes, the loss in length does appear to be minimal as compared to previous methods (Gorans, 1993; Lyon Technologies, Inc., 2006). Table 4.2 also shows the toe length variability as affected by trimming treatment and bird age. It can be seen that variability increases with both trimming and age. These results are similar to those reported by Fournier et al. (2012), who found increased toe length variability for T birds at week 12, but not week seven, and that T toes were 9.7% shorter, on average. Minor differences between studies could be due to gender or differences in the trimming procedure such as dirt build up, age of the magnetron generating the microwaves, chosen settings regarding treatment time and percentage trim (length trimmed) or operator variances (User Guide: Microwave Claw Processor (MCP), Nova-Tech Engineering, Inc., Willmar, USA).

Table 4.2. Mean toe length and variation of digits II III, and IV (n=9; mean of three toes from five birds per pen with 9 pens per treatment)

Age	Toe length (mm)			Coefficient of variation (%)		
(d)	T	NT	SEM	T	NT	SEM[1]
55	57.9[a]	63.0[b]	0.677	21.8[a]	19.4[b]	0.003
84	62.7[a]	67.8[b]	0.655	22.2[a]	20.5[b]	0.002
119	62.8[a]	67.8[b]	0.671	25.6[a]	23.6[b]	0.003
139	63.6[a]	69.3[b]	0.786	25.4[a]	22.9[b]	0.003

[a,b] Treatment means with different letters are significantly different ($P \leq 0.05$).
[1] SEM – pooled standard error of the mean.

4.4.2 Behaviour and Gait Score

The effects of toe trimming on poult behaviour at one, three and five d are shown in Tables 4.3, 4.4, and 4.5. The findings from d one show that T poults spent more time resting (81.4 vs. 56.5% of their time) and less time at the feeder (10.4 vs. 0.4%), standing (10.4 vs. 1.8%) and walking (7.3 vs. 1.4%) compared to NT poults. On d three, the T poults spent less time walking (4.8 vs. 8.9%) and more time sitting (17.6 vs. 9.1%) than NT birds. On d five, T poults spent more time resting (55.7 vs. 32.9%) and less of their time running, (0.1 vs. 0.7%), and at the feeder (4.7 vs. 16.5 %) when compared with birds from the NT treatment.

Behaviour is often used to measure pain and welfare in poultry species (Rutherford, 2002; Buchwalder, 2005; Hocking et al., 2005). For all three day of observation the T birds demonstrated less mobility than those of the NT treatment, but the degree of response lessened with age. Trimmed poults spent more time resting and sitting, both stationary behaviours, and less time running, walking, and feeding, all of which are active behaviours. This decrease in mobility suggests that toe treatment caused discomfort or pain to the poults over the short term. Fournier et al. (2012) found similar results in a trial testing MCP toe treatment in hen turkeys. One difference in the latter trial is that the decreased mobility associated with trimming was only seen on d three, on d one and by d five no effects of trimming were observed. While Owings et al. (1972) did not specifically look at behaviour, they also noted that the T poults (surgical scissors) were less active over the first three days after trimming, which they suggested was likely due to pain caused by the procedure.

Table 4.3. Behaviours of toe trimmed and not trimmed poults at 1 d of age as a percentage of time spent at notable behaviours[1] during observation (n=9). Log transformed data are in brackets

Behaviour	Trimmed	Not Trimmed	SEM[2]
Resting	81.4[a] (4.4)	56.5[b] (4.0)	4.334 (0.082)
Sitting	10.8 (2.4)	8.5 (2.2)	0.882 (0.091)
Walking	1.4[b] (0.8)	7.3[a] (1.9)	1.061 (0.187)
Standing	1.8[b] (0.9)	10.4[a] (2.3)	1.454 (0.214)
Running	0.1 (0.1)	0.2 (0.2)	0.064 (0.050)
At feeder	0.4[b] (0.3)	10.4[a] (2.2)	1.886 (0.269)
At drinker	0.6 (0.4)	1.8 (0.9)	0.357 (0.138)
Stretching	0.4 (0.3)	0.5 (0.3)	0.124 (0.080)
Litter peck	0.1 (0.1)	0.0 (0.0)	0.033 (0.026)
Head shake	0.5 (0.3)	0.1 (0.1)	0.119 (0.076)
Object peck	1.0 (0.6)	2.5 (1.1)	0.382 (0.131)
Feather peck	0.2 (0.3)	0.1 (0.1)	0.084 (0.061)

[a,b] Treatment means with different letters within an age are significantly different based on analysis of the transformed data ($P \leq 0.05$).
[1] Behaviours consistently showing ≤ 0.2% expression were omitted.
[2] SEM – pooled standard error of the mean.

Table 4.4. Behaviours of toe trimmed and not trimmed poults at 3 d of age as a percentage of time spent at notable behaviours[1] during observation (n=9). Log transformed data are in brackets

Behaviour	Trimmed	Not Trimmed	SEM[2]
Resting	53.5 (4.0)	48.3 (3.9)	3.279 (0.061)
Sitting	17.6[a] (2.9)	9.1[b] (2.2)	1.565 (0.121)
Walking	4.8[b] (1.6)	8.9[a] (2.3)	0.869 (0.152)
Standing	11.1 (2.4)	12.7 (2.6)	1.078 (0.092)
Running	0.2 (0.2)	0.2 (0.1)	0.082 (0.059)
At feeder	5.5 (1.5)	9.2 (2.2)	1.164 (0.203)
At drinker	1.1 (0.7)	2.9 (1.2)	0.448 (0.150)
Stretching	0.7 (0.4)	0.9 (0.6)	0.142 (0.086)
Litter peck	0.2 (0.2)	0.1 (0.1)	0.066 (0.051)
Head shake	0.0 (0.0)	0.1 (0.1)	0.045 (0.035)
Object peck	2.7 (1.1)	4.2 (1.5)	0.612 (0.166)
Feather peck	0.7 (0.5)	0.9 (0.6)	0.142 (0.076)

[a,b] Treatment means with different letters within an age are significantly different based on analysis of the transformed data (P<0.05).
[1] Behaviours consistently showing ≤ 0.2% expression were omitted.
[2] SEM – pooled standard error of the mean.

Table 4.5. Behaviours of toe trimmed and not trimmed poults at 5 d of age as a percentage of time spent at notable behaviours[1] during observation (n=9). Log transformed data are in brackets

Behaviour	Trimmed	Not Trimmed	SEM[2]
Resting	55.7[a] (3.9)	32.9[b] (3.3)	6.116 (0.183)
Sitting	9.8 (2.3)	8.1 (2.1)	1.005 (0.122)
Walking	7.3 (1.8)	14.5 (2.5)	2.366 (0.199)
Standing	11.9 (2.2)	12.3 (2.5)	1.700 (0.180)
Running	0.1[b] (0.1)	0.7[a] (0.5)	0.108 (0.075)
At feeder	4.7[b] (1.1)	16.5[a] (2.7)	2.276 (0.287)
At drinker	1.3 (0.7)	2.6 (1.1)	0.451(0.151)
Stretching	0.9 (0.5)	0.3 (0.2)	0.152 (0.094)
Litter Peck	0.4 (0.3)	0.1 (0.1)	0.110 (0.073)
Head shake	0.1 (0.1)	0.3 (0.2)	0.085 (0.061)
Object peck	5.6 (1.6)	8.5 (2.0)	1.257 (0.185)
Feather peck	0.3 (0.2)	0.7 (0.5)	0.125 (0.080)

[a,b] Treatment means with different letters within an age are significantly different based on analysis of the transformed data (P<0.05).
[1] Behaviours consistently showing ≤ 0.2% expression were omitted.
[2] SEM – pooled standard error of the mean.

The comparison of tom behaviour on d 133 summarized over the 24 h observation period is shown in Table 4.6. Trimmed birds spent more time standing, but less time walking compared to NT toms. The average time spent standing was 27.1% for T toms vs. 24.1% for NT toms. Toms in the NT treatment spent, on average, 5.6% of their time walking compared to 4.6% for T toms. These results are somewhat contradictory as both standing and walking are active behaviours, and so the differences between treatments are unlikely to be attributed to pain. If pain was associated with this behavioural effect, it would be expected that T birds would spend more time sitting or resting as was seen the first week after treatment. Instability is thought to be a more probable cause; while the birds are able to walk, they may choose to walk less because of reduced balance.

In the study by Fournier et al. (2012), behaviour of T and NT hens was examined at 13 weeks of age. They found no differences in behaviour in contrast to the tom data obtained at an older age in the current study. The behaviour differences between the two trials may relate to bird gender and/or bird size. On d 140, the mean weight of toms was over 21 kg (Chapter 3) while the 13 week hens only averaged slightly more than 10 kg. The impact on feed intake observed in T toms (Chapter 3) supports the argument that bird weight and/or age causes behavioural differences. At 13 weeks of age, tom feed intake was not affected by trimming, but at 19 weeks feed consumption was reduced (Chapter 3) in T birds. This reduction in feed consumption plus the altered behaviour reported in the present study are suggestive of reduced mobility in older toms.

Toe trimming did not affect gait score at any of the test ages (Table 4.7), but worsened with age. While the age effect shows that the mobility of turkeys decreases with age, it is noteworthy that the values are all quite low. These results suggest that T turkeys were not experiencing discomfort or pain at older ages. Fournier et al. (2012) examined the gait of T and NT hens at seven weeks of age and found no differences, which is in agreement with the present research.

There were positive correlations found between body weight and gait score at 12 weeks of age (r=0.32) and between the length of the outside toe on the right foot and gait score at eight weeks of age (r=0.26), but none of the remaining correlations were significant (data not shown). As the correlations between parameters were seen at only one age each, and the values were quite low, the relationships between these parameters were likely not strong.

Table 4.6. Effect of toe trimming on time budgets (% of time) summarized over 24 h of observation for toms at 133 d of age for notable behaviours[1] (n=9). Log transformed data are in brackets

Behaviour	Trimmed	Not Trimmed	SEM[2]
Resting	30.4 (3.4)	30.7 (3.5)	1.210 (0.019)
At feeder	3.7 (1.6)	3.3 (1.4)	0.194 (0.041)
At drinker	1.8 (1.0)	1.8 (1.0)	0.137 (0.086)
Standing	27.1[a] (3.3)	24.1[b] (3.2)	0.723 (0.026)
Sitting	23.5 (3.2)	26.0 (3.3)	0.606 (0.028)
Walking	4.6[a] (1.7)	5.6[b] (1.9)	0.241 (0.041)
Strutting	2.4 (1.2)	1.9 (1.1)	0.231 (0.068)
Preening	4.0 (1.6)	3.9 (1.6)	0.207 (0.035)
Litter pecking	1.2 (0.8)	1.3 (0.8)	0.109 (0.044)
Feather pecking	0.3 (0.3)	0.5 (0.4)	0.056 (0.039)

[a,b] Treatment means with different letters are significantly different based on analysis of the transformed data ($P<0.05$).
[1] Behaviours with occurrences < 0.20% were omitted.
[2] SEM – pooled standard error of the mean.

Table 4.7. Effect of age and toe treatment on average gait score and the angle (°) of the breast from horizontal (n=9)

Variable	Treatment Means		Period Means				
	Trimmed	Non-Trimmed	55d	82d	119d	139d	SEM[2]
Gait score	0.22	0.26	0.09^{a}	0.18^{ab}	0.27^{bc}	0.42^{c}	0.029
Breast angle	13.1	13.3	20.6^{a}	20.5^{a}	9.8^{b}	1.9^{c}	0.733

[a,b,c] Treatment means with different letters are significantly different ($P<0.05$).

[1] SEM – pooled standard error of the mean.

4.4.3 Posture Assessment

Studies have found that toes play a key role in balance during standing for human subjects (Menz et al., 2005; Chou et al., 2009). Because of this, it is possible that a decrease in the length of toes may cause turkeys to adjust their posture to alter their centre of gravity. In this study, posture was assessed by measuring the angle of the breast from a line parallel with the horizontal surface on which the bird was standing (Table 4.7). Toe trimming did not affect the posture or stance of turkeys assessed in this way and there was no interaction between trimming and bird age. However, age had a large effect with the angle of the breast in relationship to a horizontal line decreasing with bird age and in particular after 12 weeks of age. This is shown in Figure 4.3. These results indicate that the difference in toe length does not require the birds to re-adjust their centre of gravity. However, more severe trimming than seen in this research may be of concern as the digital flexor plays a significant role in a digit's ability to stabilize the body (Winter et al., 2003). If the toe is trimmed excessively short and the tendon attachment to the distal two phalanges is compromised, then toe functionality may decrease resulting in reduced stability (George and Berger, 1966; Urbaniak et al., 1985). The age-effect seen for posture is likely due to proportional muscle mass of the breast increasing as the toms mature.

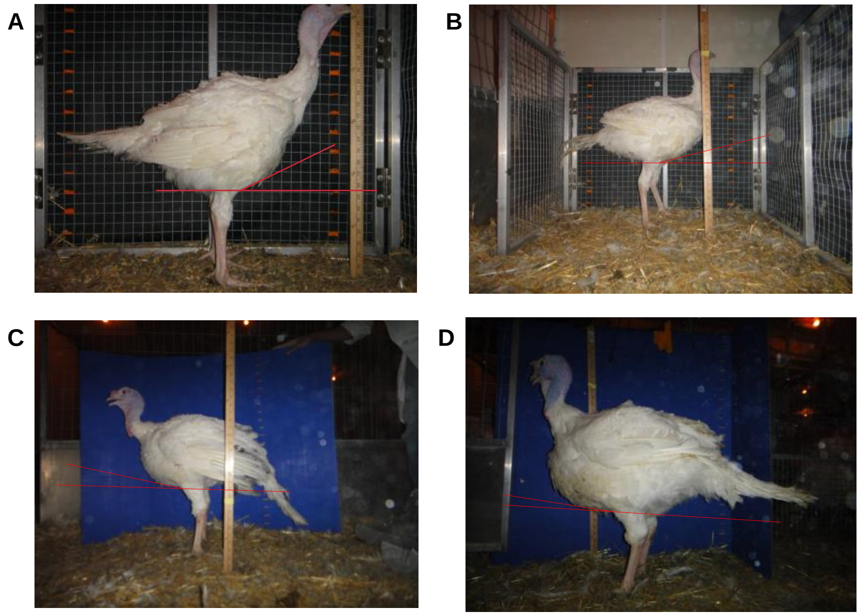

Figure 4.3. Images representing bird stance at 55 (A), 84(B), 119(C), and 139(D) d of age.

The results of Chapter 3 demonstrated that toms that have been toe trimmed consume less feed and grew more slowly that the NT birds at older ages. The gait score results show that this is not due to the ability of birds to walk and indicate that the change in performance is attributed to another factor. Based on behavioural differences, it is unlikely that pain is the factor and this is supported by the finding that at younger ages (7 to 91 d of age) there were no differences in performance for the N and NT birds. It is possible that reduced performance of T toms later in the production cycle is due to the avoidance of walking rather an inability to do so. Trimmed birds may be less stable because of a combination of the shorter toes, heavy weights, and changed stance seen at older ages. Instability might reduce frequency of trips to the feeder and cause the reduced feed intake that was noted for the T toms.

It is possible that the gait scoring method used is not sensitive to changes in bird movement that might be associated with instability. A study on the importance of toes in the human gait found that humans actively use their toes, from root to tip, while walking, and if toes (especially the largest two) are not able to be utilized, the subjects tend to use their upper body to compensate (Takemura et al., 2003). While the gait scoring system used in the current research looked for unnatural leg motion, it did not address upper body movement in the birds. Additionally, the method by Nestor et al. (1985) puts emphasis on the amount of time it takes for a bird to sit. As the behaviour analysis indicated no difference in time spent sitting, a method focusing on leg and body movement as scale markers may have been more useful.

4.4.4 Healing Process

Day zero slides from toes collected approximately 10 h post-treatment are shown in Figure 4.4. At this point heterophil recruitment to the microwaved area can be seen as well as the beginning of tissue degradation. In d four slides, the epithelium can be seen migrating to surround the healthy tissue (Figure 4.5) and by eight days post treatment the epithelium had completely re-formed around the healthy (non-treated) tissues (Figure 4.6). In the latter birds, some dead tissue had yet to be sloughed. While tissue formation was not complete at this point, having an enclosed epidermis would provide a physical barrier to the outside environment. By d 14, which was the last day of sampling, all dead tissue had been sloughed, and with the exception of the bone tissue, healing was complete (Figure 4.6). Indications of cartilage re-growth in the region of the distal phalanx at this age suggest the phalanx and the claw it supports may form again even after sloughing is complete (Figure 4.7). X-rays taken of the feet of an 18 week toe trimmed tom show that the distal phalanx is present in some toes, along with a claw, supporting the concept of regeneration, although the extent of regeneration cannot be known without further research (Figure 4.8).

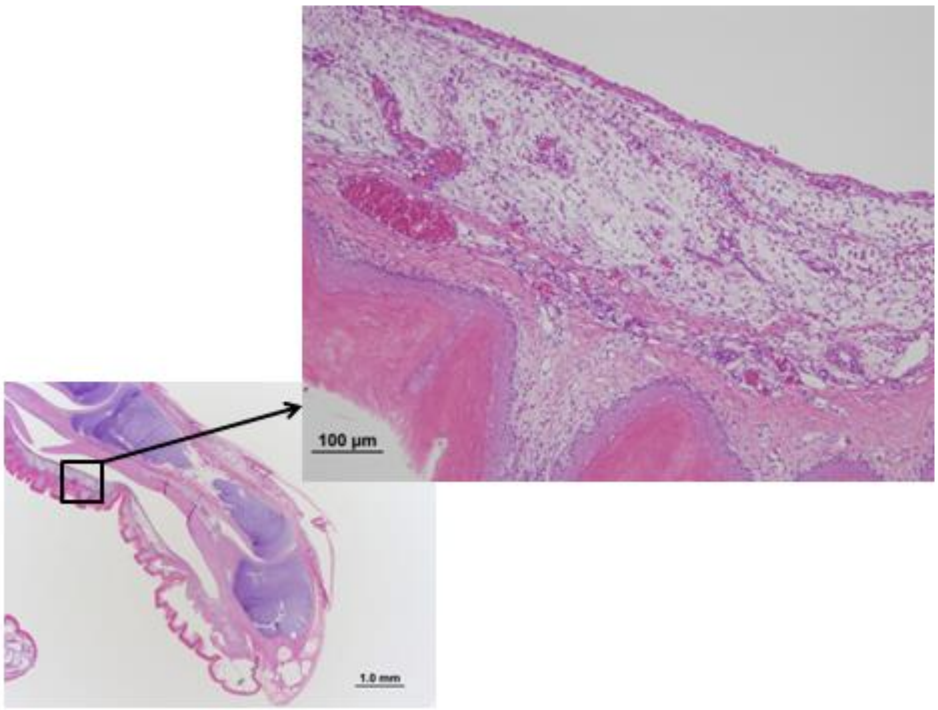

Figure 4.4. H&E stained slides of a MCP treated toe of a poult on the d of treatment. The higher magnification shows heterophil recruitment.

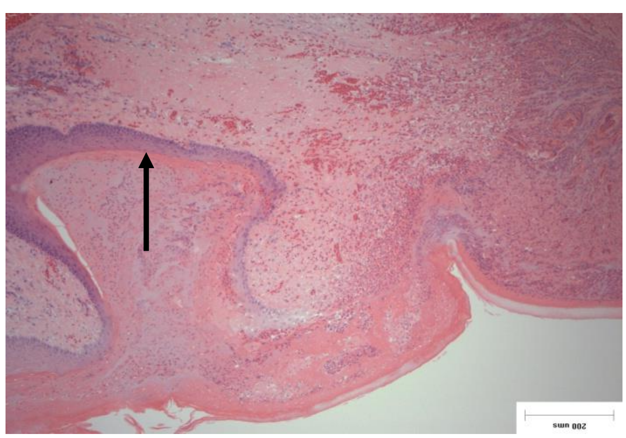

Figure 4.5. A trimmed toe four d post-treatment demonstrating epithelial migration (arrow) away from necrotic tissues to surround healthy tissue.

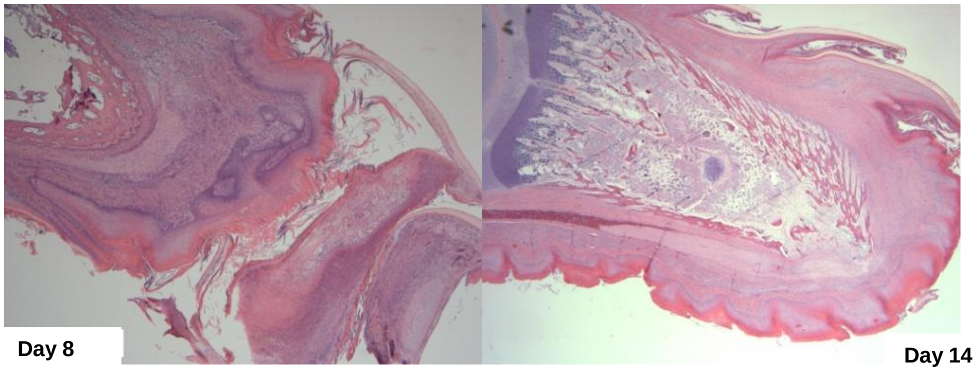

Figure 4.6. Slides of trimmed toes 8 and 14 d post-treatment. Day 8 shows the epithelium completely surrounding the remaining toe with dead tissue still connected distally (bottom right). Day 14 shows the tissues within the trimmed area are completely healed, with the exception of the bone.

Figure 4.7. Areas of cartilage (circled) suggesting terminal phalanx regrowth, leading to claw formation.

Figure 4.8. X-Ray of a foot from two 18 week toms, both treated with the MCP. The left foot demonstrates a more severe trim with the right foot showing distal phalanx growth.

One of the advantages of the MCP over the hot blade is said to be reduced risk of infection (Gorans, 1993). However, a case study by Alfonso and Barnes (2006) found that *Staphylococcus aureus* may have gained entry through toes which had been treated using a MCP. In the current study signs of bacterial infection in the trimmed toes were also found (Figure 4.9). However, this was found only in 3 of 40 samples, and may be a rare occurrence. There were also signs of blood in the shavings of one pen the day after placement indicating a disruption of the epithelial barrier. The bacteria were found in toes collected on the day of trimming, suggesting the infection occurred at the hatchery or during transport. This demonstrates that even though the toe has not been sloughed, the treatment can damage toes to a point that the skin is more susceptible to bacterial penetration. It also emphasizes the need to maintain hygienic conditions for treated turkey poults.

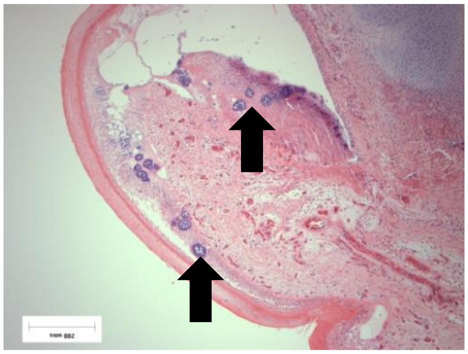

Figure 4.9. Slide of a poult's toe on the day of trimming, showing signs of infection (stained colonies indicated by the arrows).

4.4.5 Assessing Welfare through Production Characteristics

A number of the production criteria examined in Chapter 3 can also be used to assess animal welfare. The results seen in the 133 d behaviour coincide with a reduction observed in both feed consumption and body weight in T toms. The reduction in feed consumption suggests the trimming procedure reduced tom motivation to walk to the feeders.

Abundant scratching on the carcasses would be a welfare concern as each scratch would result in physical damage, causing pain. In the heavy toms, no differences were found in carcass scratching, broken limbs, or breast blisters. According to these results, toe trimming did not benefit the welfare of tom turkeys grown to larger weights. However, scratching throughout the experiment was not monitored, and scratching in young toms with intact toes may still be a concern. Further research examining scratching in toms at younger ages would provide a better picture of the pain and stress that trimmed birds experience due to scratching. While level of overall mortality and culling loss was not significantly affected by MCP treatment, there was a higher incidence of culling due to rotated tibia with toe trimming, which increases the pain experienced by the birds and decreases welfare.

4.5 Conclusions

It was hypothesized that MCP toe trimming would reduce carcass scratching in tom turkeys, which may cause pain and fear throughout a bird's life, and as a result have a positive impact on bird welfare, despite any initial pain caused by the procedure. In the current work, however, there was no reduction in carcass scratching as a result of the T treatment. Furthermore, the data indicate that MCP toe trimming causes short-term pain in poults. Reduced activity of T poults on d one, three and five are supportive of that conclusion. While there were also differences in behaviour at 133 d, which may indicate reduced mobility, the lack of significant differences in gait score and early growth rate indicate a mechanism other than chronic pain. Nevertheless the 133 d behavioural data are indicative of reduced welfare.

While there may be minimum long term welfare impacts of toe trimming, it has been demonstrated in this study, and previous studies, that toe trimming poults does cause discomfort and so, is a welfare concern for the industry. As no positive impacts were found in the toms as a result of toe trimming, this procedure should not be a recommended practice for the heavy tom industry based on the results of this research. The level of scratching at younger ages, however, should be studied before a conclusion is drawn on the net impact of this procedure on tom turkeys.

5.0 OVERALL CONCLUSIONS

Based on previous literature, it was hypothesized that toe trimming would be a beneficial procedure, with the positive effects regarding a reduction in scratching outweighing the potential pain after treatment and the cost of the procedure itself. The current study, however, found no beneficial effects on either production or welfare criteria, and multiple negative effects in both areas, causing the rejection of the hypothesis. The reduction in body weight with trimming may have been an acceptable loss if it had resulted in increased Grade A carcasses due to less scratching. Because this was not seen, performing the procedure on poults may cost a producer raising heavy toms a portion of their potential profits due to fewer kilograms produced, higher feed costs, and the opportunity cost associated with keeping the birds for more d.

The reduced feed consumption and body weight also indicate a welfare concern, as a drop in feed consumption is likely due either to loss of appetite, which may indicate physical or emotional pain or sickness, or a decrease in motivation to move to and from feeders. This is emphasised by the 133 d differences in behaviour, however, the lack of significance in both the gait scores and stance data make it confusing as to what the issue truly is. As there were no treatment differences seen in gait scores and no difference in time sitting and resting seen in the 133 d behavioural observations, it is hypothesized that the reduced feed consumption and reduction in time spent walking in the T birds were the result of poor balance associated with heavy body weight, a more horizontal stance, and shorter toes, thereby discouraging walking unless necessary. A reluctance to walk, but not to stand, may not have shown on the gait scoring scale used, which is largely based on whether and when the bird sits. Development of a gait scoring scale that more accurately assesses the bird's walking ability, such as used for broiler chickens (Garner et al. 2002), has merit and may help clarify the apparent discrepancies in the present study. Although the reason for the reduced feed intake and resulting lower body weight associated with MCP treatment are not known, it does suggest reduced welfare in tom turkeys.

While the long term welfare impacts may be unclear, poult behaviour observed on d one, three, and five as well as the decrease in feed consumption seen over that period, clearly demonstrated that on all three days of observations T poults were experiencing discomfort on some level. Similar results have been found in female poults as well (Fournier et al, 2012). As scratching remained the same for both treatments, there is no counterbalancing reason for exposing the poults to this additional discomfort.

While overall mortality was not affected by treatment, there was an increase seen in rotated tibia with trimming. The variation between the results in hens and toms is difficult to explain, however, may be due to small variations between the two studies such as handling at the hatchery. Although the studies had the same protocol for bedding, differences in straw quality or quantity may have resulted in a more slippery surface in the tom experiment, thereby causing damage to leg joints. The bacteria colonies found in the trimmed toes may also be a welfare concern. While the current study did not find a difference between treatments, bacteria gaining entry through trimmed toes may result in increased early mortality, especially if the hatchery, transport containers, or the barn are not cleaned properly. This stresses the need for sanitation standard operating procedures as well as proper MCP settings to ensure the trim is mild enough to prevent open skin wounds.

As other studies have found that toe trimming is effective in reducing scratching, the difference in the current study is thought to be due to the large bird size and the reduced mobility that accompanies it. Both treatments in the current work showed little scratching, suggesting that heavy toms show a naturally low tendency to scratch, leaving little for the toe treatment to improve upon. Based on the results of previous studies, it is a concern that, although the NT toms showed no increased scratching at 140 d, the occurrence of scratching may have been higher when the birds were smaller and more mobile. While this would not impact carcass grade in birds kept to older ages, the impact on bird welfare still needs to be considered. Because of this, more research may be needed to determine if there is a market weight when toe trimming tom poults is no longer necessary at. Additional research that examines scratching of toms and hens at the same body weight would also be useful to clarify the importance of gender. Should an increase in scratching in young NT birds be found a concern, the results from the poult behaviour in both the current and previous studies, showing pain caused by the procedure suggest that alternate methods of controlling scratching should be looked into. Methods such as manipulation of housing and environment, without physical alterations to the birds, if functional, would be ideal for reducing pain and fear experienced by the birds and improving bird welfare.

Further research has already begun to determine if these effects seen in the current research remain true at a commercial level, where management and housing may vary greatly from the research facility. Previous research has already suggested differences between the two may exist. Without small pens to restrict bird movement, a higher incidence of scratching may be seen in commercial settings, however, it might also be seen that the differences in feed consumption may be more pronounced in a larger area. Until that research is completed, it will be difficult to provide an accurate recommendation to the industry in regard to the use of MCP treatment for tom turkeys. However, based solely on the current study, toe trimming cannot be recommended for heavy tom production.

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Appendix 1. Commercial turkey tom six-step diet composition

	Pre-Starter	Starter	Grower	Developer	Finisher 1	Finisher 2
Metabolizable Energy (Kcal/kg)	2841	2865	2944	2985	3000	3015
Crude Protein (Min %)	28.0	26.0	24.5	22.50	20.50	18.50
Crude Fat (Min %)	3.0	3.0	3.0	3.0	3.0	3.0
Crude Fiber (Max %)	4.0	4.0	4.0	4.0	4.0	4.0
Calcium (%)	1.7	1.6	1.4	1.20	1.05	1.0
Phosphorus (%)	0.7	1.0	0.90	0.70	0.70	0.70
Sodium (%)	0.17	0.17	0.17	0.17	0.17	0.17
Vitamin A (IU/kg)	15910	13600	12000	11000	10600	10000
Vitamin D (IU/kg)	4420	4420	3900	3575	3460	3250
Vitamin E (IU/kg)	106	100	52	50	50	50